# High- and low-frequency repeating icequakes in the Mont-Blanc massif

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Unstable fast slip at the base of glaciers produce seismic signals that can be used to better understand basal slip.
In the Mont-blanc area, we have detected both high frequency icequakes (central frequency of about 100 Hz, duration 0.1 sec) and low frequency icequakes (main frequency around 5 Hz, duration of about 5 s).
Both types of events occur as clusters of repeating events with highly similar waveforms, regular inter-event times of a few minutes and progressive changes in amplitude and recurrence times.
But they occur at different times and different places.
High-frequency earthquakes occur all over the year under temperate glaciers and are not sensitive to meteorological forcings.
In contrast, low frequency earthquakes occur mainly during and after snowfalls and are located at higher elevation, mainly above 3000 m asl
where there is possibly cold basal ice.
We suggest that high frequency icequakes are associated with the repeated failure of asperities (rock debris?) loaded by stable sliding
around the asperity.
Low-frequency icequakes seem to be rather associated with cold based glaciers, that deform mainly by viscous deformation.
This viscous deformation increases the stress at the base of the glacier and may trigger repeated ruptures at the ice-bed interface.
High- and low-frequency icequakes share similarities with high- and low-frequency earthquakes.
Low-frequency events occur at the transition between stable and unstable zones: at the base of the seismogenic zone for tectonic faults,
and possibly at the transition between cold and temperate ice for glaciers.
They are more sensitive than high frequency events to very small stress perturbation (tides for earthquakes and snow loading for icequakes).
They also have a slower rupture velocity.
Characterizing the source properties (rupture length, slip, rupture velocity) of basal icequakes is difficult based on existing data.
Therefore we cannot determine which fraction of glacier deformation is produced by seismic events.